REMARKS

Claims 1 through 47 are pending in the application.

Claims 1 through 47 stand rejected under 35 U.S.C. § 112, first paragraph,

Claims 1, 2, 4, 5, 8, 9, 12-19, and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi et al. (English translation of JP-39528) taken with Price et al.

Claims 3, 6, 7, 10, 11, 20, 22, and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi taken with Price as applied to claims 1, 2, 4, 5, 8, 9, 12-19, and 21, and further in view of Brors et al. (U.S. Pat. 4,565,157).

The Office Action mailed May 12, 2000, has been received and reviewed. Applicant has amended claims 1, 8, 18, 24, 33, and 39, and respectfully requests reconsideration of the application as amended herein.

35 U.S.C. § 112 Claim Rejections

Claims 1 through 47 stand rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Applicant respectfully traverses this rejection, as hereinafter set forth.

Claims 1 through 47 are rejected on the basis that Applicant's disclosure of a method for depositing tungsten silicide characterized by the formula WSi_x, without defining or specifying the numerical values of x, fails to meet the requirements of 35 U.S.C. § 112, first paragraph. More particularly, the disclosure allegedly fails to enable the claims. Applicant disagrees.

"The test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation." *U.S. v. Telectronics Inc.*, 8 U.S.P.Q.2d 1217, 1223 (Fed. Cir. 1988) (*citing Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1384, 231 U.S.P.Q. 81, 94 (Fed. Cir. 1986), *cert. denied* 107 S.Ct. 1606 (1987)) (emphasis added); *see also MPEP* § 2164.01. Applicant has satisfied this test.

The disclosure of the present invention adequately describes the methods and processes by which the invention claimed in claims 1 through 47 may be practiced. The Specification provides one working example of the present invention:

> By way of example and not limitation, at a temperature of about 450°C. and with a silane flow rate of about 400 sccm, this nucleation layer is deposited in about 1-25 seconds. This requires a flow of reactant gas (WF_6) of about 4 sccm and a flow of inert gases (Ar, N_2, He) of about 2800 sccm. Following deposition of the nucleation layer the silicon source gas may be switched abruptly or gradually to dichlorosileane and the tungsten silicide film can be deposited to the desired thickness using the dichlorosilane as the source gas. *Specification*, col. 3, line 62 through col. 4, line 3.

Therefore, the Specification does not fail to enable the formation of tungsten silicide under the enumerated conditions.

The Specification also provides a detailed description of the use of a CVD system to carry out the process and methods of the present invention. *See, Specification*, col. 3, lines 4-62. The desired reactant gas (WF_6), inert carrier gases (e.g. Ar, N_2, He), and silicon source gases which include silane (SiH_4) and dichlorosilane (SiH_2Cl_2) are each described in the Specification. Furthermore, the Specification defines the process parameters including the necessary flow rates of the gases and the desired temperature ranges:

> The flow rate of the carrier gases (Ar, N_2, He) may be as great as five to ten times the flow rate of the silicon source gas (either silane or dichlorosilane). The flow rate of the silicon source gas (either silane or dichlorosilane) in turn may be about 50-100 times the flow rate of the reactant gas. *Specification*, col. 3, lines 39-44.

> A temperature of the silicon wafers 18 during both steps of the deposition process (i.e. nucleation and deposition) will be on the order of about 450°C. or less and may be in the range of 200°C. to 500°C. *Specification*, col. 4, lines 6-9.

Given these parameters, no experimentation is needed to practice the present invention. A person having ordinary skill in the art would be able to perform the present invention by charging a CVD system with the necessary gases, setting the temperature within the ranges given, and following the operation description detailed in the Specification.

Claims 1, 8, 18, 24, 33, and 39, have also been amended herein, removing the WSi_x limitation to which the Official Action objects. The deposition of tungsten silicide as claimed in

claims 1 through 47 is at least enabled by the Specification descriptions. "When analyzing the enabled scope of a claim, the teachings of the specification must not be ignored because claims are to be given their broadest reasonable interpretation that is consistent with the specification." *MPEP* § 2164.08. Giving the claims "their broadest reasonable interpretation" in light of the Specification, tungsten silicides which may be deposited using the parameters defined by the Specification are enabled. Claims 1 through 47 should be allowed on this basis alone.

The enablement inquiry does not end with the teachings of the Specification. The state of the prior art may also be coupled with the disclosure to enable the claims. *See, U.S. v. Telectronics Inc.*, 8 U.S.P.Q.2d 1217, 1223 (Fed. Cir. 1988). At the time the instant application was filed, the characterization of tungsten silicide as WSi_x was well-known in the prior art. One having ordinary skill in the art would understand that WSi_x covered those compositions of tungsten silicide which could be formed in CVD systems using the processes defined by the Specification.

As previously stated, the instant application at least specifically defines WSi_x as WSi_2. *See, Specification*, col. 1, lines 15-18. The Official Action dismisses this fact on the basis that the WSi_2 formation was disclosed in a discussion of the prior art rather than in a discussion of the present invention. This is nonsensical in light of the enablement test enunciated in *Telectronics*. Knowledge generally available in the art may be coupled with the disclosure to enable the claims. As the Specification points out, "tungsten silicide, generally in the form of (WSi_2), can be used in the formation of integrated circuits as an intermediate, barrier, or conducting film." *Specification*, col. 1, lines 15-18. Coupling this general knowledge with the process disclosure in the Specification, the claims are enabled with respect to WSi_2.

The Specification also specifically cites to issued patents and prior art references which describe the nature of tungsten silicide deposition known in the art at the time the application was filed. *See, Specification*, col. 1, lines 50-63. Of particular note is the reference entitled "Properties of WSi_x using dichlorosilane in a single-wafer system." The title itself indicates that the characterization of tungsten silicide as WSi_x was commonly used in the prior art.

Furthermore, as the Examiner notes, United States Patent No. 4,851,295 issued to Brors describes the deposition of WSi_x where x is typically between 2.0 and 4.0. Similarly, Ohba (United States Patenet No. 4,902,645) describes the deposition of tungsten silicide WSi_x where x is between 0.01 and 0.1. Since tungsten silicides WSi_x having x values in the ranges of 2.0 to 4.0 and 0.01 and 0.1 were well known and described in the prior art, the characterization of tungsten silicide as WSi_x in the present invention also encompasses these ranges.

The Examiner also notes that "the desired stoichiometry of a tungsten silicide film having a general formula WSi_x is known to depend largely on the deposition conditions such as active gases flow rates, deposition temperature, etc, and the resulted silicide film possesses different electrical characteristic." *See, Official Action*, p. 7, lines 3-6 (emphasis added). If it was known that the characteristics of WSi_x depended upon the deposition conditions, then claims 1 through 47 are enabled because the deposition conditions are clearly defined in the Specification.

Additionally, the reference "Properties of WSi_x using dichlorosilane in a single-wafer system" defines tungsten silicide as WSi_x, especially in the context of CVD processes. As pointed out in the reference, it was known at the time of the application that the silicon to tungsten ratio in WSi_x deposition is a function of deposition temperature at fixed flow rates. Changes in the temperature or in the reactant gas flow rate would change the value of x in the WSi_x characterization. This knowledge can be coupled with the descriptions in the Specification, thereby enabling claims 1 through 47.

The contention that "undue experimentation" is required to is also misplaced. None of claims 1 through 47 claim the deposition of a particular form of tungsten silicide (e.g. WSi_2). Rather, the claims are directed towards a process of depositing tungsten silicide on a substrate. As long as the process parameters are followed no experimentation is required to make the present invention. A person using the present invention need not know what form of tungsten silicide is being formed as long as the tungsten silicide is formed.

In summary, the Specification itself is sufficient to enable the deposition of those forms of tungsten silicide which may be deposited using the gas flow rates, temperatures, and processes

described in Specification. Knowledge of the particular form of tungsten silicide being deposited is irrelevant as long as the a tungsten silicide is formed using the processes described. Furthermore, when the Specification is read in light of the prior art existing at the time the application was filed, claims 1 through 47 are enabled. Numerous forms of tungsten silicide were commonly known and defined in the prior art. Tungsten silicides were even commonly referred to or defined by the formula WSi_x. Thus, defining tungsten silicide as WSi_x in the Specification would be known and understood by one having ordinary skill in the art.

Claims 1 through 47 are enabled, especially in light of the amendments contained herein, by both the Specification and by the Specification coupled with the knowledge generally available in the prior art. No "undue experimentation" would be required to carry out the present invention because the process parameters are defined in the Specification. Therefore, the rejection of claims 1 through 47 based upon 35 U.S.C. § 112, first paragraph, should be withdrawn. Furthermore, claims 24 through 47 are not the subject of any further objections, and therefore, should be allowed for issue.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on Japanese Patent No. JP-39528 to Kawanishi et al. Taken With U.S. Patent No. 4,632,057 to Price et al.

Claims 1, 2, 4, 5, 8, 9, 12 through 19, and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi et al. (Japanese Patent No. JP-39528) taken with Price et al. (U.S. Patent No. 4,632,057). Applicant respectfully traverses this rejection, as hereinafter set forth.

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, **there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings.** Second, there must be a reasonable expectation of success. Finally, **the prior art reference (or references when combined) must teach or suggest**

> **all the claim limitations.** The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

The 35 U.S.C. § 103(a) obviousness rejections of claims 1, 2, 4, 5, 8, 9, 12 through 19, and 21 are improper because a *prima facie* case of obviousness has not been established. Kawanishi and Price et al., individually or collectively, fail to motivate the present invention and teach or suggest all of the claim limitations, including the amendments to claims 18 and 19.

Kawanishi teaches a two-step tungsten silicide deposition process. A first tungsten silicide film is formed on a substrate in the presence of silane (SiH_4) and tungsten hexaflouride (WF_6) at a temperature of 360°C. The substrate is then transferred to a second reaction chamber wherein a second tungsten silicide deposition is carried out in the presence of dichlorosilane (SiH_2Cl_2) and tungsten hexaflouride (WF_6) at a temperature of 680°C. *See, Kawanishi* at 6. Kawanishi makes it clear that the first deposition is a low temperature deposition and the second deposition is a high temperature deposition. Kawanishi also notes that a low temperature deposition followed by a high temperature deposition is preferred because low temperature depositions alone are disadvantageous. *See, Kawanishi* at 4.

Price et al. teach a one-step tungsten silicide deposition process initiated by a plasma discharge within a deposition chamber. The single-step deposition process occurs in the presence of dichlorosilane (SiH_2Cl_2) and tungsten hexaflouride (WF_6) at a temperature of 450°C after deposition initiation is triggered by plasma discharge. *See, Price et al.* at col. 9, lines 1-12.

Applicant has previously argued that the combination of Kawanishi and Price et al. do not support the ongoing obviousness rejection under 35 U.S.C. § 103(a). In the first instance, there is no motivation in Kawanishi to combine a two-step low/high temperature deposition with a single step low temperature deposition to arrive at the two-step low temperature deposition of the present invention. Likewise, Price et al. do not motivate a combination with Kawanishi. Furthermore, Kawanishi and Price et al. fail to teach all of the claim limitations of the rejected claims. The failure of both Kawanishi and Price et al. to individually or collectively teach all of

the claim limitations of the present application and their failure to motivate a two-step low temperature deposition process precludes a finding of a *prima facie* case of obviousness.

Responding to Applicant's arguments that there is no motivation to combine the two references, the Examiner states that "applying Price's teaching to the process of Kawanishi with motivation as recited in the rejection which results in a combined process which does not include the plasma ignition step." *See, Official Action* at pp.8-9 (emphasis added). The only motivation which Applicant gleans from the rejection (Section 2 *Official Action*) is that:

> one skill in the art [sic] would find it obvious to deposit the WSi_2 film of Kawanishi at the temperature range suggested by Price because lower temperature deposition would be beneficial in that thermal budget is reduced while assuring substantially the same deposition characteristics (e.g. temperature/deposition rate independency, film thickness uniformity) as the film is deposited at 680°C. *Official Action* at 4.

Neither reference states that deposition characteristics of low temperature and high temperature depositions are the same as stated in the rejection. In fact, Kawanishi teaches just the opposite. Kawanishi specifically states that "the WSi_2 film formed by such a low-temperature treatment had a poor adhesion with the substrate and a poor step coverage." *See, Kawanishi* at 4. Applicant acknowledges the Examiner's contention that Kawanishi is referring to a single deposition step at a low temperature, but point out that Kawanishi does not indicate that it is a single deposition step, only that it is "a method." More importantly, Kawanishi indicates that the low temperature tungsten silicide film and the high temperature tungsten silicide film deposited by the Kawanishi two-step method have different film qualities, thus, the deposition characteristics are not the same as propounded by the Examiner. *See, Kawanishi* at 10. This directly conflicts the only motivation offered in the rejection, and precludes the obviousness rejection.

Additionally, the nature of the processes taught respectively by the references precludes a combination of the two. Price et al. teaches a one-step deposition process whereas Kawanishi teaches a two-step deposition process. There is no motivation to combine a one-step process with a two-step process to form an alternate two-step process. Furthermore, neither Price et al. nor Kawanishi indicate that any advantages exist with a two-step, low temperature deposition process. Therefore, no motivation exists for one of ordinary skill in the art to even consider

combining the two references.

It is also argued that the low temperature deposition step of Price et al. could be incorporated with Kawanishi without a plasma deposition process. More specifically, the *Official Action* recites that "Price et al. teaches that once a nucleation layer of tungsten disilicide was formed by initiating a plasma discharge in a short time, tungsten disilicide (WSi_2) can be deposited by CVD from a mixture of SIH_2Cl_2 and WF_6 at a temperature in a range of 390-400°C without the presence of plasma." *See, Official Action* at 3. Applicant concedes that once the Price et al. deposition is initiated with a plasma discharge, the deposition may continue without the presence of further plasma discharge. However, Price et al. does not teach that a low temperature deposition would occur without the plasma discharge. Price et al. teaches that the "plasma discharge serves to initiate the deposition of silicon." *See, Price et al.* at col. 7, lines 37-38 and col. 5, lines 60-63. Without the plasma discharge, the deposition reaction of Price et al. does not occur.

Price et al. does not support the contention that if a tungsten silicide nucleated substrate is placed in the environment described by Price et al., spontaneous deposition would occur if the wafer was maintained at a certain temperature. Even if the low temperature, tungsten silicide, nucleated substrate formed in the first step of Kawanishi was placed in the reaction chamber of Price et al., deposition would not occur unless a plasma discharge was used to initiate or 'kick start' the deposition because the plasma discharge is necessary to initiate the deposition. *See, Price et al.* at col. 5, lines 60-64. Therefore, it would make no sense to combine Price et al. with Kawanishi because a plasma discharge would still be required.

The lack of motivation to combine Kawanishi and Price et al. precludes the finding of a *prima facie* case of obviousness and the rejection of claims 1, 2, 4, 5, 8, 9, 12 through 19, and 21 under 35 U.S.C. § 103(a).

The third requirement of a *prima facie* case of obviousness is also lacking. Kawanishi and Price et al. fail to teach all of the elements of the rejected claims. Specifically, Kawanishi fails to teach a two-step deposition of tungsten silicide performed at a temperature of less than about

500°C as in claims 1, 2, 5, 8, 9, and 13-17. Likewise, Kawanishi fails to teach a two-step deposition of tungsten silicide performed at a temperature of less than about 400°C as in claims 4 and 21. Furthermore, Kawanishi fails to teach a two-step deposition process wherein both steps are effected at a substantially equivalent temperature as recited in claims 16-19 and 21. The failure of Kawanishi to teach the deposition temperature limitations of the present invention precludes a *prima facie* case of obviousness.

Price et al. also fails to teach all of the limitations of the claims of the present invention. Price et al. specifically describe a single step deposition at a temperature around 400°C wherein the deposition itself is initiated by plasma discharge. The Price et al. deposition is also carried out using a single silicon source gas, rather than two separate silicon source gases as in the two-step process of the present invention. The lack of a teaching of a two-step deposition process, and the failure of Price et al. to teach deposition at a temperature in the range of 390-400°C using two separate silicon source gases precludes a *prima facie* case of obviousness based on Price et al.

Furthermore, claims 18, 19, and 21 should be allowed over Kawanishi and Price et al. Claim 18 has been amended to include the claim language "said switching said silane silicon source gas to said dicholorosilane silicon source gas occurring without interrupting said (CVD) process." Kawanishi specifically describes a two-step deposition process wherein the substrate upon which the deposition is occurring is removed from the reaction chamber following the low temperature deposition so that the process conditions may be changed before reinserting the substrate into the same, or a different, reaction chamber for the high temperature deposition step. Thus, Kiwanishi fails to describe a two-step deposition process wherein the CVD process is uninterrupted. Price et al. also fails to describe a two-step deposition process occurring without interruption of the CVD process. Failing to describe an uninterrupted CVD process, Kawanishi and Price et al. do not make obvious claim 18, nor claims 19 and 21 which depend therefrom.

Additionally, claims 2, 4, 5, 9,12-17, 19, and 21 are allowable because they depend from a non-obvious independent claim. *See, In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988)(dependent claims are nonobvious under section 103 if the independent claims from

which they depend are nonobvious).

For the foregoing reasons, claims 1, 2, 4, 5, 8, 9, 12-19, and 21 should be allowed over the 35 U.S.C. § 103(a) rejection based upon the unmotivated combination of Kawanishi and Price et al.

Obviousness Rejection Based on Japanese Patent No. JP-39528 to Kawanishi et al. Taken With U.S. Patent No. 4,632,057 to Price et al., and Further in View of U.S. Patent No. 4,565,157 to Brors et al.

Claims 3, 6, 7, 10, 11, 20, 22, and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi et al. (Japanese Patent No. JP-39528) taken with Price et al. (U.S. Patent No. 4,632,057), as applied to claims 1, 2, 4, 5, 8, 9, 12 through 19, and 21 above, and further in view of Brors et al. (U.S. Patent No. 4,565,157). Applicant respectfully traverses this rejection, as hereinafter set forth.

Claims 3, 6, 7, 10, 11, 20, 22, and 23 each depend from independent claims 1, 8, or 18. As dependent claims, claims 3, 6, 11, 20, 22, and 23 are not obvious if the independent claims from which they depend are nonobvious. *See*, *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988); *see also*, MPEP § 2143.03. As explained *supra*, independent claims 1, 8, and 18 are nonobvious, therefore claims 3, 6, 7, 10, 11, 20, 22, and 23 are nonobvious.

Furthermore, the combination of Brors with Kawanishi and Price et al. fails to establish a prima facie case of obviousness of claims 3, 6, 7, 10, 11, 20, 22, and 23. There is no motivation to combine the cold wall CVD reactor of Brors with Kawanishi or Price et al. to achieve deposition of tungsten silicide as taught in the present invention. Likewise, the combined teachings of Brors, Kawnaishi and Price et al. would necessitate a plasma ignition step to achieve the deposition of tungsten silicide, which is not present in the current invention. The lack of motivation to combine Brors with Kawanishi and Price et al., and the expectation of failure without a plasma ignition step as in Price, precludes a prima facie case of obviousness. Therefore, claims 3, 6, 7, 10, 11, 20, 22, and 23 are nonobvious and allowable over the combination of Brors

with Kawanishi and Price et al.

ENTRY OF AMENDMENTS

The amendments to claims 1, 8, 18-24, 33, and 39, above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add any new matter to the application. Further, the amendments do not raise new issues or require a further search.

CONCLUSION

Claims 1 through 47 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicant's undersigned attorney.

Respectfully Submitted,

Devin R. Jensen
Registration Number 44,805
Attorney for Applicant
TRASK BRITT
P.O. Box 2550
Salt Lake City, Utah 84110
Telephone: (801) 532-1922

DRJ/ps:kf
Date: August 14, 2000

N:\2269\3369.1\Amendment - 14Aug00.wpd